The Critical Concepts

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January 2016 | Draft Version 2.0

OUR MISSION
To provide the best research, the most useful actions, and the highest level of services to educators.

OUR VISION
To continuously develop tools that translate high-quality educational research into practical applications educators can put to immediate use.

OUR GOAL
To be the place educators go for the latest information and data, synthesized into clear, concise resources that facilitate immediate action.

Marzano Research would like to thank the following individuals for their contributions to this project:

Robert J. Marzano
Christopher Dodson
Ming Lee Newcomb
Elizabeth A. Bearden
Laurel Hecker
Tom Roy
Diane Paynter
Jennifer Norford
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Suggested Citation:

Simms, J. A. (2016). *The critical concepts (draft version 2.0)*. Centennial, CO: Marzano Research.

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Introduction

In 1999, Robert Marzano and John Kendall led a team of researchers at Mid-Continent Research for Education and Learning (McREL) to estimate how much time would be required to teach the 200 academic standards and 3,093 benchmarks in the McREL standards database. The standards and benchmarks were compiled from national and state standards documents and covered fourteen different subject areas. Marzano and Kendall's team surveyed 350 practicing teachers, asking each one to "estimate the amount of time (rounded to the nearest hour) it would take to 'adequately address' the content in a representative sample of benchmarks from the database" (Marzano & Kendall, 1999, p. 102). Based on the evidence they collected, they concluded that "it would take 15,465 hours to cover all 3,093 benchmarks" (p. 104).

To accompany their estimate of the time required to teach all of the benchmarks, Marzano and Kendall (1999) estimated how much instructional time is available to teachers across the K–12 educational interval. They concluded that, using the most optimistic scenarios, 9,042 hours might be available for instruction during a students' career in the United States K–12 education system. Clearly, trying to teach 15,000 hours of content in 9,000 hours of instructional time is a frustrating predicament.

The creation of the Common Core State Standards (CCSS) and the Next Generation Science Standards (NGSS) presented an opportunity to alleviate this issue. However, multiple analyses (for example, Marzano & Yanoski, 2015; Marzano, Yanoski, Hoegh, & Simms, 2013; Porter, McMaken, Hwang, & Yang, 2011) have revealed that the updated standards documents still articulate more content than is practicable to teach in the instructional time available. Many teachers recognize this dilemma and must therefore make several unenviable decisions: Do I try to cover all the content in a cursory manner? Do I select specific aspects of the content and teach those well, while deemphasizing (or ignoring) other aspects? How do I know which aspects are most important? Problems such as the following often arise when teachers must make these difficult decisions.

- **Teachers who attempt to cover all the content are overwhelmed.** This might mean that they do not have time to clearly articulate appropriate learning goals, design rigorous instructional activities, or closely assess and track students' learning.
- **Teachers who select specific aspects of the content to focus on are influenced by inappropriate guidelines.** This might mean that a teacher prioritizes only that content which appears on a standardized test students are required to take at the end of the year.
- **Teachers who teach the same courses prioritize different aspects of the content.** This might mean that the content a student learns in a class is dependent on the teacher to whom he or she is assigned.

To address these problems, analysts at Marzano Research sought to—as objectively as possible—identify a focused set of critical concepts for each K–12 grade level in the content areas of English language arts (ELA), mathematics, and science. We strove to:

- Draw from a wide range of sources and standards documents to ensure that all available content was considered and ranked.

- Inform our analysis with blueprint data from standardized tests (such as the Partnership for Readiness in College and Careers [PARCC] and Smarter Balanced Assessment Consortium [SBAC] summative assessments) to ensure that content critical to students' success on those assessments was included.
- Use an objective process to identify individual content elements and group them into meaningful topics.

To provide evidence for review, we preserved all of our working papers and attached metadata to every content element; our goal was to be able to explain why any element was included or not included in our set of critical concepts.

This report describes the multi-phase process we used to define the Critical Concepts. The explanations of phases 1 through 5 detail how we identified key measurement topics in the areas of ELA, mathematics, and science (see appendices A, B, and C for complete lists). The descriptions of phases 6 and 7 explain the process we used to compose proficiency scales, or learning progressions, for each of the measurement topics. This report also contains recommendations that schools that purchase the Critical Concepts proficiency scales (available in the summer of 2016) can use to customize the scales for their unique needs and specific situations.

As evident in the title, this report is the second in a series of versions that will be released as future phases and aspects of the project are completed. After completing phases 1–7 for ELA, mathematics, and science, we plan to identify critical concepts and compose proficiency scales in two additional areas: social studies and cognitive skills.

Phase 1

To begin, we collected standards from three sources:

- Grades K–8: *Making Standards Useful in the Classroom* (Marzano & Haystead, 2008)
- Grades K–12: *Common Core State Standards* (National Governors Association for Best Practices & Council of Chief State School Officers, 2010a, 2010b)
- Grades K–12: *Next Generation Science Standards* (NGSS Lead States, 2013)

Making Standards Useful in the Classroom presented an analysis of all available standards documents in 2008 (including the 200 standards and 3,093 benchmarks in the McREL standards database). In that book, Marzano and Haystead (2008) analyzed and condensed the standards and benchmarks into proficiency scales (measurement tools that clearly articulate the content to be taught and assessed) for grades K–8 in the content areas of language arts, mathematics, science, social studies, and life skills. We drew from this source to ensure that we included all standards documents published prior to the CCSS and NGSS.

Next, we analyzed the test blueprints for the PARCC and SBAC summative assessments to determine which content was included on those assessments and its relative importance to students' success. We rated each standard as high (H) importance, medium (M) importance, or low (L) importance for each test. *It is important to note that this data informed our analysis but*

did not drive it. Throughout the process, we revisited which content was important for students' success on the tests, and sought to include it without focusing on it exclusively.

Table 1 shows the grade levels and content areas of the standards included in our analysis, the sources standards were drawn from for each grade level and content area, and an indication of whether we were able to assign importance ratings to standards in those areas for the PARCC and SBAC summative assessments.

Table 1. Sources and Available Rating Data

Level	Source	PARCC Ratings Available	SBAC Ratings Available
Kindergarten ELA	MSU, CCSS	no	no
Kindergarten Math	MSU, CCSS	no	no
Kindergarten Science	MSU, NGSS	no	no
Grade 1 ELA	MSU, CCSS	no	no
Grade 1 Math	MSU, CCSS	no	no
Grade 1 Science	MSU, NGSS	no	no
Grade 2 ELA	MSU, CCSS	no	no
Grade 2 Math	MSU, CCSS	no	no
Grade 2 Science	MSU, NGSS	no	no
Grade 3 ELA	MSU, CCSS	yes	yes
Grade 3 Math	MSU, CCSS	yes	yes
Grade 3 Science	MSU, NGSS	no	no
Grade 4 ELA	MSU, CCSS	yes	yes
Grade 4 Math	MSU, CCSS	yes	yes
Grade 4 Science	MSU, NGSS	no	no
Grade 5 ELA	MSU, CCSS	yes	yes
Grade 5 Math	MSU, CCSS	yes	yes
Grade 5 Science	MSU, NGSS	no	no
Grade 6 ELA	MSU, CCSS	yes	yes
Grade 6 Math	MSU, CCSS	yes	yes
Grade 7 ELA	MSU, CCSS	yes	yes
Grade 7 Math	MSU, CCSS	yes	yes
Grade 8 ELA	MSU, CCSS	yes	yes
Grade 8 Math	MSU, CCSS	yes	yes
Middle School Science	MSU, NGSS	no	no
Grades 9–10 ELA	CCSS	yes	no
Grades 11–12 ELA	CCSS	yes	yes
High School Math	CCSS	yes	yes
High School Science	NGSS	no	no

Key: MSU = *Making Standards Useful in the Classroom;* CCSS = *Common Core State Standards;* NGSS = *Next Generation Science Standards*

As shown in table 1, summative assessment data was available for grades 3–8 in ELA and mathematics. At the high school level, PARCC summative assessment data was available for grades 9–12 in ELA and mathematics, and SBAC summative assessment data was available for grade 11 in ELA and grades 9–12 in mathematics.

Finally, in phase 1, we divided each standard into its related vocabulary terms and component parts. For example, consider the following standard from the CCSS for grade 4 mathematics.

> Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding. (CCSS.MATH.CONTENT.4.OA.A.3)

There are a number of key vocabulary terms in this standard, including *operation, remainder, equation, unknown, reasonableness, mental computation, estimation,* and *rounding.* There are also a number of elements of knowledge or skill, including:

- Solve multistep word problems posed with whole numbers and having whole-number answers using addition
- Solve multistep word problems posed with whole numbers and having whole-number answers using subtraction
- Solve multistep word problems posed with whole numbers and having whole-number answers using multiplication
- Solve multistep word problems posed with whole numbers and having whole-number answers using division, including problems in which remainders must be interpreted
- Represent multistep word problems using equations with a letter standing for the unknown quantity
- Assess the reasonableness of answers using mental computation
- Assess the reasonableness of answers using estimation strategies
- Assess the reasonableness of answers using rounding

Readers will notice that the preceding list of knowledge and skills were identified simply by linguistically separating the individual phrases and clauses from the standard. All of the original wording and language from the standard have been retained; each element has simply been separated from the others. This was intentional as it was an extremely objective method of identifying discrete elements of knowledge or skill. Using this method, individual raters could obtain the same results, regardless of their biases, backgrounds, or levels of expertise with the content. Table 2 (p. 7) illustrates the result of the initial phase of our analysis for the previously referenced standard.

Table 2. Data for CCSS.MATH.CONTENT.4.OA.A.3 After Phase 1

Standard	Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding. (CCSS.MATH.CONTENT.4.OA.A.3)
Importance rating on PARCC summative	H
Importance rating on SBAC summative:	H
Vocabulary	*operation*
	remainder
	equation
	unknown
	reasonableness
	mental computation
	estimation
	rounding
Component Parts	solve multistep word problems posed with whole numbers and having whole-number answers using addition
	solve multistep word problems posed with whole numbers and having whole-number answers using subtraction
	solve multistep word problems posed with whole numbers and having whole-number answers using multiplication
	solve multistep word problems posed with whole numbers and having whole-number answers using division, including problems in which remainders must be interpreted
	represent multistep word problems using equations with a letter standing for the unknown quantity
	assess the reasonableness of answers using mental computation
	assess the reasonableness of answers using estimation strategies
	assess the reasonableness of answers using rounding

Each vocabulary term and component part was labeled with all its associated data (that is, standard, importance ratings, strand, source, and so on).

Phase 2

We began phase 2 by moving all vocabulary terms to a separate document and isolating the component parts. Then, we sorted the component parts into categories by grouping similar component parts together. In some cases, we used keywords to determine that two component parts were similar. In other cases, we determined that one component part referred to a subskill that was part of a larger skill referenced in another component part. There were a few cases where two component parts were grouped together because the skills articulated in each were clearly best addressed together.

Once all of the component parts within a content area for one grade level had been sorted, we named each category (to facilitate reference to groupings later in the process) and used Microsoft Excel to order the list of components by four nested criteria:

1. Category name (alphabetical)
2. Importance rating on PARCC summative assessment (H, M, L)
3. Importance rating on SBAC summative assessment (H, M, L)
4. Component part (alphabetical)

Sorting the component parts in this way allowed us to assign each category an importance rating for the PARCC and SBAC summative assessments based on the component parts within it. Again, our goal was to allow the PARCC and SBAC summative assessments to inform our analysis, but not drive it.

As stated, we assigned each category an importance rating for the PARCC and SBAC summative assessments by examining the component parts within it—specifically, each component part's importance rating based on the standard from which it was drawn.

- If a category contained component parts from standards that were rated H for both the PARCC and SBAC summative assessments, we assigned that category a rating of 1.
- If a category contained component parts from standards that were rated H for either the PARCC or the SBAC summative assessments (but not both), or if a category contained component parts that were rated M or L on both the PARCC and SBAC summative assessments, we assigned that category a rating of 2.
- If a category contained component parts from standards that were rated M or L on either the PARCC or SBAC summative assessments (but not both), or if a category contained component parts from standards that were not addressed by either the PARCC or SBAC summative assessments, we assigned that category a rating of 3.

Readers should keep in mind that these ratings were not used to make final decisions about which standards were or were not essential. Instead, we used them to inform our decisions and remain aware of the knowledge and skills that students would need to be successful on summative assessments, so as not to inappropriately exclude such content. For subjects or grade levels without summative assessment ratings (e.g., science), no category ratings were assigned.

The final step of phase 2 involved using Excel to order the list once again, but this time according to five nested criteria:

1. Category rating (numerical)
2. Category name (alphabetical)
3. Importance rating on PARCC summative assessment (H, M, L)
4. Importance rating on SBAC summative assessment (H, M, L)
5. Component part (alphabetical)

Table 3 (p. 9) illustrates the result of the second phase of our analysis for the category of Comparisons for grade 4 mathematics.

Table 3. Data for the Mathematics Category of Comparisons at Fourth Grade After Phase 2

Component Part	Standard Code	Source Standard	PARCC	SBAC
compare two fractions with different numerators and different denominators by comparing to a benchmark fraction such as 1/2	4.NF.A.2	Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as 1/2. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model.	H	H
compare two fractions with different numerators and different denominators by creating common denominators or numerators	4.NF.A.2	Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as 1/2. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model.	H	H
distinguish multiplicative comparison from additive comparison	4.OA.A.2	Multiply or divide to solve word problems involving multiplicative comparison, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem, distinguishing multiplicative comparison from additive comparison.	H	H
explain why a fraction *a*/*b* is equivalent to a fraction ($n \times a$)/($n \times b$) by using visual fraction models	4.NF.A.1	Explain why a fraction *a*/*b* is equivalent to a fraction ($n \times a$)/($n \times b$) by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions.	H	H
interpret a multiplication equation as a comparison (e.g., interpret 35 = 5 × 7 as a statement that 35 is 5 times as many as 7 and 7 times as many as 5)	4.OA.A.1	Interpret a multiplication equation as a comparison, e.g., interpret 35 = 5 × 7 as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as multiplication equations.	H	H
justify the conclusions of fraction comparisons (e.g., by using a visual fraction model)	4.NF.A.2	Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as 1/2. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model.	H	H
pay attention to how the number and size of parts differ even though two fractions themselves are the same size	4.NF.A.1	Explain why a fraction *a*/*b* is equivalent to a fraction ($n \times a$)/($n \times b$) by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions.	H	H
recognize that fraction comparisons are valid only when the two fractions refer to the same whole	4.NF.A.2	Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as 1/2. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model.	H	H

Component Part	Standard Code	Source Standard	PARCC	SBAC
record the results of fraction comparisons with symbols >, =, or <	4.NF.A.2	Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as 1/2. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model.	H	H
use the principle that the number and size of parts can differ even though two fractions themselves are the same size to generate equivalent fractions	4.NF.A.1	Explain why a fraction *a*/*b* is equivalent to a fraction ($n \times a$)/($n \times b$) by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions.	H	H
use the principle that the number and size of parts can differ even though two fractions themselves are the same size to recognize equivalent fractions	4.NF.A.1	Explain why a fraction *a*/*b* is equivalent to a fraction ($n \times a$)/($n \times b$) by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions.	H	H
compare two multi-digit numbers based on meanings of the digits in each place	4.NBT.A.2	Read and write multi-digit whole numbers using base-ten numerals, number names, and expanded form. Compare two multi-digit numbers based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons.	H	M
recognize that in a multi-digit whole number, a digit in one place represents ten times what it represents in the place to its right	4.NBT.A.1	Recognize that in a multi-digit whole number, a digit in one place represents ten times what it represents in the place to its right. *For example, recognize that 700 ÷ 70 = 10 by applying concepts of place value and division.*	H	M
use >, =, and < symbols to record the results of comparisons between two multi-digit numbers	4.NBT.A.2	Read and write multi-digit whole numbers using base-ten numerals, number names, and expanded form. Compare two multi-digit numbers based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons.	H	M
compare two decimals to hundredths by reasoning about their size	4.NF.C.7	Compare two decimals to hundredths by reasoning about their size. Recognize that comparisons are valid only when the two decimals refer to the same whole. Record the results of comparisons with the symbols >, =, or <, and justify the conclusions, e.g., by using a visual model.	H	L
express a fraction with denominator 10 as an equivalent fraction with denominator 100	4.NF.C.5	Express a fraction with denominator 10 as an equivalent fraction with denominator 100, and use this technique to add two fractions with respective denominators 10 and 100. *For example, express 3/10 as 30/100, and add 3/10 + 4/100 = 34/100.*	H	L
justify the results of decimal comparisons using a visual model	4.NF.C.7	Compare two decimals to hundredths by reasoning about their size. Recognize that comparisons are valid only when the two decimals refer to the same whole. Record the results of comparisons with the symbols >, =, or <, and justify the conclusions, e.g., by using a visual model.	H	L
recognize that decimal comparisons are valid only when the two decimals refer to the same whole	4.NF.C.7	Compare two decimals to hundredths by reasoning about their size. Recognize that comparisons are valid only when the two decimals refer to the same whole. Record the results of comparisons with the symbols >, =, or <, and justify the conclusions, e.g., by using a visual model.	H	L

Component Part	Standard Code	Source Standard	PARCC	SBAC
record the results of decimal comparisons with the symbols >, =, and <	4.NF.C.7	Compare two decimals to hundredths by reasoning about their size. Recognize that comparisons are valid only when the two decimals refer to the same whole. Record the results of comparisons with the symbols >, =, or <, and justify the conclusions, e.g., by using a visual model.	H	L
know relative sizes of measurement units within one system of units (e.g., knowing that 1 ft is 12 times as long as 1 in)	4.MD.A.1	Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. *For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...*	M	M
record measurement equivalents in a two-column table (e.g., for feet and inches, [1, 12], [2, 24], [3, 36] and so on)	4.MD.A.1	Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. *For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...*	M	M
within a single system of measurement, express measurements in a larger unit in terms of a smaller unit (e.g., a 4 ft snake is 48 in)	4.MD.A.1	Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. *For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...*	M	M
extend relationships	MSU.4. BP.2	While engaged in grade-appropriate tasks, the student demonstrates an understanding of basic patterns by extending patterns and relationships *(e.g., explaining and exemplifying the rule to extend a given pattern).*		
label whole numbers on a number line to 100	MSU.4. ARMM.2	While engaged in grade-appropriate tasks, the student demonstrates an understanding of algebraic representations and mathematical models by plotting and labeling whole numbers on a number line to 100 *(e.g., explaining and exemplifying how to construct a number line and modeling the steps required to plot and label various whole numbers up to 100).*		
order whole numbers (millions), decimals (thousandths), and fractions with like denominators (e.g., converting between whole numbers, decimals, and fractions for accurate comparison)	MSU.4. NSNS.1	While engaged in grade-appropriate tasks, the student demonstrates an understanding of numbers and number systems by ordering and comparing whole numbers (millions), decimals (thousandths), and fractions with like denominators *(e.g., converting between whole numbers, decimals, and fractions for accurate comparison).*		
plot whole numbers on a number line to 100	MSU.4. ARMM.2	While engaged in grade-appropriate tasks, the student demonstrates an understanding of algebraic representations and mathematical models by plotting and labeling whole numbers on a number line to 100 *(e.g., explaining and exemplifying how to construct a number line and modeling the steps required to plot and label various whole numbers up to 100).*		

As shown in table 3, the category of Comparisons involved component parts from a number of different standards, and the category's importance rating for PARCC and SBAC summative assessments was 1, because it contained component parts from standards of high importance on both tests.

Phase 3

The third phase of our analysis resembled the second phase in that it involved sorting similar component parts into groups and labeling those groups. However, phase 3 differed from phase 2 in that we focused on one category at a time. For each category, we examined the component parts within that category and grouped similar component parts together, creating subgroups within each category. For example, within the category of Subtraction, we grouped the component parts shown in table 4 together because they all related to subtracting fractions with like denominators that refer to the same whole.

Table 4. Component Parts Within the Category of Subtraction Related to Subtracting Fractions With Like Denominators That Refer to the Same Whole

Component Part	Standard Code	Source Standard
understand subtraction of fractions as separating parts referring to the same whole	4.NF.B.3.A	Understand addition and subtraction of fractions as joining and separating parts referring to the same whole.
solve word problems involving subtraction of fractions referring to the same whole and having like denominators by using equations to represent the problem	4.NF.B.3.D	Solve word problems involving addition and subtraction of fractions referring to the same whole and having like denominators, e.g., by using visual fraction models and equations to represent the problem.
solve word problems involving subtraction of fractions referring to the same whole and having like denominators by using visual fraction models to represent the problem	4.NF.B.3.D	Solve word problems involving addition and subtraction of fractions referring to the same whole and having like denominators, e.g., by using visual fraction models and equations to represent the problem.
perform subtraction of fractions with common denominators	MSU.4.BAS.2	While engaged in grade-appropriate tasks, the student demonstrates an understanding of basic addition and subtraction by performing addition and subtraction of fractions with common denominators *(e.g., explaining and modeling the steps required to solve an addition or subtraction problem containing fractions with common denominators).*
solve problems involving subtraction of fractions by using information presented in line plots	4.MD.B.4	Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Solve problems involving addition and subtraction of fractions by using information presented in line plots. *For example, from a line plot find and interpret the difference in length between the longest and shortest specimens in an insect collection.*

In some cases, as we grouped component parts within categories, we realized that specific component parts had been miscategorized during the phase 2 categorization, and would actually fit better in a different category. When that was the case, we labeled the component part as "miscategorized" and moved it to the end of the list. After all component parts in all categories had been grouped, we assigned the miscategorized component parts to more appropriate categories and subgroups.

In other cases, component parts referred to knowledge or skills in ways that were very general. For example, consider the following component part from standard CCSS.ELA-LITERACY.RI.4.10:

> Comprehend grade-appropriate informational texts proficiently.

Although this component part articulates an important skill for students to acquire, it is not as specific as other component parts, which more clearly articulate the knowledge and skills requisite to comprehending grade-appropriate informational texts proficiently. Such component parts were labeled as "general" and collected at the end of the list.

Next, we wrote an element for each subgroup; an element is a statement describing knowledge or a skill. For the subgroup of component parts shown in table 4, we wrote the following element:

> Students will subtract fractions with like denominators that refer to the same whole.

We strove to make the elements unidimensional; that is, each element should express only one aspect of knowledge or a skill. All elements began with the phrase "students will . . ." and summarized the subgroup of component parts to which they referred. If a subgroup contained component parts which could not be summarized by a unidimensional element, the subgroup was split into smaller groups until a unidimensional element could be composed for each one.

Finally, we assigned an importance rating for the PARCC and SBAC summative assessments to each element, using a similar process to the one used during phase 2:

- If an element contained component parts from standards that were rated H for both the PARCC and SBAC summative assessments, we assigned that element a rating of 1.
- If an element contained component parts from standards that were rated H for either the PARCC or the SBAC summative assessments (but not both), or if an element contained component parts that were rated M or L on both the PARCC and SBAC summative assessments, we assigned that element a rating of 2.
- If an element contained component parts from standards that were rated M or L on either the PARCC or SBAC summative assessments (but not both), or if an element contained component parts from standards that were not addressed by either the PARCC or SBAC summative assessments, we assigned that element a rating of 3.

Thus, each element had two summative assessment importance ratings associated with it: one for the category it was in and one for the element itself. Table 5 (p. 14) shows the elements identified for grade 4 mathematics during the third phase of our analysis. Although not shown in table 5, our working papers tracked the source standard (and all related metadata) for each component part within each element.

Table 5. Elements Identified for Grade 4 Mathematics During Phase 3

Category Rating	Element Rating	Element
1	1	Students will add fractions with like denominators that refer to the same whole.
1	1	Students will assess the reasonableness of answers.
1	1	Students will compare fractions with different numerators and different denominators.
1	1	Students will decompose a fraction into a sum of fractions with a common denominator.
1	1	Students will explain and illustrate their reasoning when performing division.
1	1	Students will explain and illustrate their reasoning when performing multiplication.
1	1	Students will express mixed numbers with like denominators as equivalent fractions.
1	1	Students will generate equivalent fractions.
1	1	Students will represent a problem by composing an equation with a number or symbol standing for an unknown quantity.
1	1	Students will solve word problems involving division of whole numbers (dividends up to four digits and one-digit divisors).
1	1	Students will solve word problems involving multiplication of a fraction by a whole number.
1	1	Students will solve word problems involving multiplication of whole numbers (up to four-digit factor by a one-digit factor or two two-digit factors).
1	1	Students will solve word problems involving the addition of multi-digit whole numbers (up to four digits).
1	1	Students will solve word problems involving the subtraction of multi-digit whole numbers (up to four digits).
1	1	Students will subtract fractions with like denominators that refer to the same whole.
1	1	Students will understand the relationship between factors and multiples.
1	1	Students will understand, represent, and solve multiplicative comparisons.
1	2	Students will compare decimal numbers (to thousandths).
1	2	Students will compare multi-digit whole numbers (up to millions).
1	2	Students will convert between whole numbers, decimals, and fractions.
1	2	Students will find unknown angle measures on a diagram using addition or subtraction.
1	2	Students will generate equivalent measurements (using larger or smaller units) within a system of measurement.
1	2	Students will identify all factor pairs for a whole number between 1 and 100.
1	2	Students will identify multiples of a whole number between 1 and 100.
1	2	Students will round multi-digit whole numbers to any place.
1	2	Students will solve word problems involving the addition of simple decimals referring to distance, time, volume, mass, and money.
1	2	Students will solve word problems involving the addition of simple fractions referring to distance, time, volume, mass, and money.
1	2	Students will solve word problems involving the division of simple decimals referring to distance, time, volume, mass, or money.
1	2	Students will solve word problems involving the division of simple fractions referring to distance, time, volume, mass, or money.

Category Rating	Element Rating	Element
1	2	Students will solve word problems involving the multiplication of simple decimals referring to distance, time, volume, mass, or money.
1	2	Students will solve word problems involving the multiplication of simple fractions referring to distance, time, volume, mass, or money.
1	2	Students will solve word problems involving the subtraction of simple decimals referring to distance, time, volume, mass, and money.
1	2	Students will solve word problems involving the subtraction of simple fractions referring to distance, time, volume, mass, and money.
1	3	Students will order whole, fraction, and decimal numbers up to 100.
2	2	Students will analyze a pattern to identify the rule used to generate it and describe its features.
2	2	Students will find the area of rectangles and squares.
2	2	Students will find the perimeter of rectangles, squares, and triangles.
2	2	Students will identify line-symmetric figures and draw lines of symmetry in them.
2	2	Students will identify, draw, and compare acute, obtuse, and right angles.
2	2	Students will identify, draw, and compare lines, line segments, points, and rays.
2	2	Students will measure and sketch angles in whole-number degrees.
2	2	Students will read and write multi-digit whole numbers using base-ten numerals.
2	2	Students will read and write multi-digit whole numbers using expanded form.
2	2	Students will read and write multi-digit whole numbers using number names.
2	2	Students will recognize, draw, and compare parallel, perpendicular, and oblique lines.
2	2	Students will recognize, draw, and compare parallelograms, rhombuses, trapezoids, and right triangles.
2	2	Students will represent numerical data using bar graphs, line graphs, line plots, and tables.
2	2	Students will understand important concepts related to angle measurement.
2	2	Students will use a given rule to generate or extend a shape or number pattern.
2	3	Students will collect data using experiments, observations, and surveys.
2	3	Students will demonstrate flips (reflections) on hexagons, octagons, pentagons, and quadrilaterals.
2	3	Students will demonstrate slides (translations) on hexagons, octagons, pentagons, and quadrilaterals.
2	3	Students will demonstrate turns (rotations) on hexagons, octagons, pentagons, and quadrilaterals.
2	3	Students will find the area of triangles.
2	3	Students will represent categorical data using bar graphs, line graphs, line plots, tables, and tally charts.
2	3	Students will understand the relationship between area and perimeter.
3	3	Students will calculate elapsed time (hours and minutes).
3	3	Students will construct and compare cubes and prisms.
3	3	Students will describe the proper order of operations in an expression.
3	3	Students will estimate and measure length using U.S. customary (to the nearest 1/8 inch) and metric units (to the nearest millimeter).

Category Rating	Element Rating	Element
3	3	Students will explain and represent the associative property for multiplication.
3	3	Students will explain and represent the commutative property for multiplication.
3	3	Students will explain and represent the distributive property for multiplication.
3	3	Students will find the volume of a cube.
3	3	Students will measure temperature using Fahrenheit (°F) and Celsius (°C) units.
3	3	Students will measure time.
3	3	Students will predict possible outcomes as likely, unlikely, certain, equally likely, or impossible.
3	3	Students will use ordered pairs to find locations on a grid or map.

Phase 4

During phase 4, we sorted the elements into tentative measurement topics. This involved grouping similar elements together and assigning tentative measurement topic titles to each group. We preserved the category and element ratings, listing them before each element. Table 6 lists the tentative measurement topics and elements for grade 8 ELA after phase 4.

Table 6. Elements for Grade 8 ELA Sorted Into Tentative Measurement Topics After Phase 4

Claims, Evidence, and Reasoning
1—1 Students will identify specific claims and the evidence given for them.
1—1 Students will evaluate specific claims and the evidence given for them.
1—1 Students will evaluate the relevancy of evidence for a claim.
1—1 Students will evaluate the sufficiency of evidence for a claim.
1—1 Students will identify irrelevant evidence.
1—1 Students will support claims with logical reasoning.
1—1 Students will support claims with relevant evidence.
1—2 Students will support claims with clear reasons.
1—2 Students will differentiate claims from alternate or opposing claims.
1—3 Students will react to textual arguments.
2—2 Students will introduce claims.
2—2 Students will organize evidence and reasons logically.
3—3 Students will present well-reasoned claims in a detailed, supported manner.
3—3 Students will recognize a variety of fallacies in an argument.
3—3 Students will write complex persuasive compositions.
Information Evaluation
1—1 Students will assess the accuracy of presented information.
1—1 Students will assess the credibility of presented information.
1—3 Students will analyze the logic of an extended oral presentation.
1—3 Students will respond to information presented by others.
3—3 Students will pose questions informed by others' responses.
Main Idea and Theme
2—2 Students will describe how a central idea develops over the course of a text.
2—2 Students will describe how a theme develops over the course of a text.
2—2 Students will describe a central idea's relationship to elements of the text.
2—2 Students will describe a theme's relationship to elements of the text.
2—3 Students will compare and contrast themes that occur across multiple works from a specific time period.

Text Comparisons
2—2 Students will describe how a live or filmed production departs from or remains faithful to the source text.
2—2 Students will describe how a modern work of fiction draws on character types from classic texts.
2—2 Students will describe how a modern work of fiction draws on patterns of events from classic texts.
2—2 Students will describe how a modern work of fiction draws on themes from classic texts.
2—2 Students will evaluate the production choices in a live or filmed interpretation of a text.
2—2 Students will evaluate the advantages and disadvantages of using different mediums to convey ideas.
Textual Evidence
1—1 Students will cite textual evidence that supports an analysis of the text.
1—1 Students will gather supporting evidence from texts.
1—1 Students will identify conflicting information in texts.
1—1 Students will examine how texts address conflicting information.
1—1 Students will effectively use search terms to gather relevant information from multiple sources.
1—2 Students will draw on multiple sources to answer a question.
1—3 Students will refer to textual evidence in discussions.
1—3 Students will use effective interviewing techniques to gather information.
1—3 Students will ask questions that require a speaker to reconcile contradictory or inconsistent information on a topic.
3—3 Students will come to discussions prepared, having read and researched materials.
Summarizing
2—2 Students will provide an objective summary of a text.
3—3 Students will identify problems that will not be solved in texts.
Point of View
1—1 Students will determine point of view.
1—1 Students will determine purpose.
1—3 Students will revise writing for appropriate point of view.
2—2 Students will describe how differences in points of view can create humor in a text.
2—2 Students will describe how differences in points of view can create suspense in a text.
2—2 Students will establish a point of view.
3—3 Students will effectively employ voice in their writing.
3—3 Students will proofread for point of view while drafting writing.
Organization and Structure
1—3 Students will organize information by generating multi-level outlines.
2—2 Students will analyze the structure of texts.
2—2 Students will compare and contrast the structure of two texts.
2—2 Students will describe the role of specific paragraphs and sentences in the development of a text.
2—2 Students will explain how a text makes connections among content.
2—2 Students will explain how a text makes distinctions among content.
2—2 Students will effectively organize content in informative/explanatory texts.
2—2 Students will organize elements of the text into broader categories.
2—2 Students will use a variety of transitions to convey progression.
2—2 Students will use a variety of transitions to create cohesion in a text.
2—2 Students will use technology to present relationships.
2—2 Students will use transitions to clarify the relationships among content.
2—3 Students will identify multiple story lines in a complex plot.
3—3 Students will identify causal relationships in grade-appropriate texts.
3—3 Students will pose questions that connect the ideas of several speakers.
Drafting
2—2 Students will use technology to produce writing.
2—2 Students will write routinely over extended time frames (time for research, reflection, and revision).
2—2 Students will write routinely over shorter time frames (a single sitting or a day or two).
3—3 Students will check for clarity while drafting writing.

Narrative Development
2—2 Students will examine how particular lines of dialogue in a text affect the development of a story or character.
2—2 Students will examine how incidents in a text affect the development of a story or character.
2—2 Students will write narratives about imagined events or experiences.
2—2 Students will establish context.
2—2 Students will introduce characters.
2—2 Students will use description to develop content.
2—2 Students will use dialogue to develop content.
2—2 Students will write narratives about real events or experiences.
2—2 Students will use pacing to develop content.
2—2 Students will use reflection to develop content.
2—2 Students will use relevant descriptive details to develop writing.
2—2 Students will use sensory language to develop writing.
3—3 Students will vary sentence forms in their writing.
Research
1—2 Students will conduct short research projects to answer a question.
1—2 Students will generate related questions while conducting a short research project.
2—3 Students will present well-reasoned findings in a detailed, supported manner.
Citations
1—1 Students will avoid plagiarism when citing others.
1—1 Students will follow a standard format for citation when citing others.
Content Selection
2—2 Students will analyze relevant content when writing informative/explanatory texts.
2—2 Students will select relevant content when writing informative/explanatory texts.
2—2 Students will develop topics with relevant content.
Multimedia and Formatting
2—2 Students will integrate multimedia into projects.
2—2 Students will integrate visual displays into projects.
2—2 Students will use formatting to aid comprehension.
Audience and Purpose
1—1 Students will plan writing so it consistently addresses audience.
1—1 Students will plan writing so it consistently addresses purpose.
1—1 Students will produce writing that is appropriate to audience.
1—1 Students will produce writing that is appropriate to purpose.
1—1 Students will produce writing that is appropriate to task.
1—1 Students will revise writing so it consistently addresses audience.
1—1 Students will revise writing so it consistently addresses purpose.
1—1 Students will rewrite so writing consistently addresses audience.
1—1 Students will rewrite so writing consistently addresses purpose.
1—1 Students will edit their writing so it consistently addresses audience.
1—1 Students will edit their writing so it consistently addresses purpose.
1—3 Students will demonstrate an understanding of audience.
1—3 Students will demonstrate an understanding of purpose.
3—3 Students will adjust presentation techniques based on audience reactions.
Style
2—2 Students will maintain the use of a formal style.
2—3 Students will use formal English when appropriate.
3—3 Students will compose formal letters.
Presentation
3—3 Students will give presentations including extended persuasive presentations.
3—3 Students will use appropriate volume, pronunciation, and eye contact while presenting.

Introductions
2—2 Students will preview what is to follow when introducing a topic.
Conclusions
2—2 Students will write a conclusion that follows from the content presented.
2—2 Students will write a conclusion that reflects on the content presented.
2—2 Students will write a conclusion that supports the content presented.
Revision
1—3 Students will revise writing for clarity.
1—3 Students will revise writing for consistent voice.
1—3 Students will use revision tools while revising.
Collaboration
2—2 Students will use technology to interact with others.
3—3 Students will define individual roles in group settings as needed.
3—3 Students will follow rules for collegial discussions.
3—3 Students will follow rules for decision-making in group settings.
3—3 Students will participate in a range of collaborative discussions with a variety of groups.
3—3 Students will track their progress.
Meaning and Language
1—1 Students will use domain-specific vocabulary when writing about a topic.
1—1 Students will use precise language to develop writing.
1—2 Students will describe the impact of specific word choices.
1—2 Students will distinguish between connotative and denotative meanings.
1—2 Students will interpret the meaning of figurative language.
1—2 Students will use word relationships to better understand words in context.
1—3 Students will explain how current events influence the development of language.
2—2 Students will acquire new academic vocabulary.
2—2 Students will consult reference materials to determine a word's precise meaning.
2—2 Students will use common Greek roots and affixes to help them determine the meaning of words.
2—2 Students will use common Latin roots and affixes to help them determine the meaning of words.
2—2 Students will use context to help them determine the meaning of words and phrases.
2—2 Students will use reference materials to find a word's part of speech and pronunciation.
2—3 Students will describe the literal meaning of figurative language.
Conventions
2—2 Students will correct inappropriate shifts in verb usage.
2—2 Students will demonstrate command of the conventions of English capitalization when writing.
2—2 Students will demonstrate command of the conventions of standard English punctuation when writing.
2—2 Students will demonstrate command of the conventions of standard English spelling when writing.
2—2 Students will explain the function of verbals.
2—2 Students will form verbs in a variety of moods.
2—2 Students will use a variety of punctuation marks to indicate a pause.
2—2 Students will write verbs in the active voice to achieve particular effects.
2—2 Students will write verbs in the passive voice to achieve particular effects.
2—3 Students will correctly use standard English mechanics.
2—3 Students will demonstrate fluid use of all verb tense forms.
2—3 Students will proofread for tense use and purposeful tense shifts in their writing.
2—3 Students will use spelling conventions to help them determine the meaning of words.
Text Analysis
3—3 Students will examine persuasive techniques for validity.
3—3 Students will examine significant literary devices in an analysis of a work.
3—3 Students will examine the importance of setting in an analysis of a work.
3—3 Students will examine the relationships among various forms of poetry in an analysis of a genre.

Phase 5

During phase 5, two raters with curriculum experience reviewed the lists of tentative measurement topics and elements. They classified each element as:

- Content that is so general that it is implicit in other elements;
- Content that should be reinforced during instruction but not formally assessed; or
- Content that should be taught and formally assessed.

Content that was so general as to be implicit in other elements was deleted. Content that should be reinforced during instruction but not formally assessed was listed separately at the end of each set of measurement topics for a grade level and content area. Finally, content that should be taught and formally assessed was either kept in its current measurement topic or moved to a different one if the rater determined that to be most appropriate. Category and element importance ratings, when available, informed these judgments but did not drive them.

Raters also examined the tentative measurement topics. In some cases, they retained the measurement topic title; in others they made slight revisions to the measurement topic title; and for the remainder, they created new measurement topic titles. At the end of phase 5, the category and element ratings were replaced by bullets and the words "students will" were removed so that each bullet began with a verb. The result of phase 5 for grade 8 ELA is shown in table 7.

Table 7. Measurement Topics and Elements for Grade 8 ELA After Phase 5

Analyzing Text Organization and Structure
• Identify relationships among content in a text
• Describe the role of specific paragraphs and sentences in the development of a text
Analyzing Ideas and Themes
• Describe the main idea or theme in a text
• Describe how a main or central idea or theme develops over the course of a text
• Describe a main or central idea's or theme's relationship to other elements of the text
Analyzing Claims, Evidence, and Reasoning
• Compare arguments to alternate or opposing arguments
• Evaluate the relevancy, sufficiency, credibility, and accuracy of evidence for a specific claim
• Identify errors in reasoning (i.e., logical errors, fallacies) in an argument
Analyzing Narratives
• Describe how events and dialogue in a text affect the development of the story
• Describe how events and dialogue in a text reveal the development of character
Analyzing Point of View and Purpose
• Describe the point of view in a text
• Describe the purpose of a text
• Describe how differences in the point of view of the reader and the characters in a text can create dramatic irony
Comparing Texts
• Describe the faithfulness of a live or filmed production to a source text
• Describe how a work of fiction draws on character types, patterns of events, and themes from classic texts
• Compare various media (including genres such as poetry, prose, and drama) by stating the advantages and disadvantages of expressing ideas in each

Analyzing Language
• Determine the denotative meaning of words using reference materials, Greek and Latin roots and affixes, and context
• Interpret the connotative meaning of words and the meaning of figurative language
Generating Text Organization and Structure
• Organize and logically order content into categories
• Generate an introduction that previews what is to follow
• Use transitions to create connections and clarify relationships in a text
• Generate a conclusion that summarizes and logically follows from the information or evidence presented
Generating Claims, Evidence, and Reasoning
• Generate claims and distinguish them from counterclaims
• Support claims with relevant and sufficient evidence as well as logical reasoning
Generating Narratives
• Introduce the conflict, setting (or context), and characters of a story
• Use description (including sensory details), dialogue, and reflection to develop a narrative
Considering Point of View, Purpose, and Audience
• Establish a clear point of view when writing
• Write for a specific purpose
• Write for a specific audience
Revision and Style
• Revise writing for a specific audience and purpose
• Rewrite sentences so that syntax and sentence forms are varied
• Revise writing to maintain a formal style
Appropriate Verb Usage
• Use active and passive verbs to achieve particular effects
• Understand the function of a variety of verb tenses and moods
Using Appropriate Citations
• Use a standard citation format
• Avoid plagiarism
Editing
• Edit writing for proper use of commas, dashes, and ellipses
• Edit writing for capitalization and proper formatting of titles
• Edit writing for spelling errors

Appendices A, B, and C list the Critical Concepts measurement topics for English language arts (appendix A), mathematics (appendix B), and science (appendix C).

Phases 6 and 7

As of January 2016, phases 6 and 7 of the project, which involve creating a proficiency scale for each Critical Concepts measurement topic, are still in progress. The following sections describe each of those phases.

Phase 6

During phase 6, work papers from previous phases were used to match each element with the standard(s) from which it was drawn. Table 8 shows the standards associated with each element for several measurement topics from grade 8 ELA (bold font indicates the part[s] of a standard on which each element is based).

Table 8. Standards Associated With Elements of Selected Measurement Topics for Grade 8 ELA

Analyzing Claims, Evidence, and Reasoning		
• Compare arguments to alternate or opposing arguments	CCSS.ELA-LITERACY.RI.8.8	Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.
	CCSS.ELA-LITERACY.SL.8.3	Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced.
• Evaluate the relevancy, sufficiency, credibility, and accuracy of evidence for a specific claim	CCSS.ELA-LITERACY.RI.8.8	Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.
	CCSS.ELA-LITERACY.W.8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
	CCSS.ELA-LITERACY.SL.8.3	Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced.
	MSU.8. AEOM.3	While participating in grade-appropriate oral communication, the student formulates thoughtful conclusions about the content and delivery by analyzing the credibility of the speaker *(e.g., determining credibility on an issue by checking a speaker's bio for degrees, publications, and other information that might indicate adequate knowledge to present opinions about the topic).*
	MSU.8. AEOM.4	While participating in grade-appropriate oral communication, the student formulates thoughtful conclusions about the content and delivery by checking the accuracy of information presented by the speaker *(e.g., confirming the accuracy of a speaker's use of statistics to support a claim that appears unlikely to be true).*
	MSU.8.OC.1	While participating in grade-appropriate oral communication, the student demonstrates the ability to listen critically and respond appropriately by analyzing the logic of an extended oral presentation *(e.g., analyzing how effectively the speaker supports claims made during a presentation).*

Analyzing Claims, Evidence, and Reasoning (continued)		
• Identify errors in reasoning (i.e., logical errors, fallacies) in an argument	CCSS.ELA-LITERACY.RI.8.8	Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.
	CCSS.ELA-LITERACY.SL.8.3	Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced.
	MSU.8. AEOM.1	While participating in grade-appropriate oral communication, the student formulates thoughtful conclusions about the content and delivery by analyzing the speaker's presentation for less common informal fallacies such as use of faulty reasoning and presence of obstacles to clarity and accuracy *(e.g., determining when a speaker makes an incorrect assumption and explaining why the assumption is inaccurate).*
	MSU.8. AEOM.2	While participating in grade-appropriate oral communication, the student formulates thoughtful conclusions about the content and delivery by analyzing the speaker's use of invalid and less common persuasive techniques such as appeals to personality, tradition, and rhetoric *(e.g., determining when a speaker appeals to tradition and explaining why this type of argument is invalid).*
	MSU.8.RMI.2	While engaged in grade-appropriate reading tasks, the student demonstrates an ability to identify and react to textual arguments *(e.g., summarizing the argument presented and explains why he or she was persuaded or not).*
Analyzing Point of View and Purpose		
• Describe the point of view in a text	CCSS.ELA-LITERACY.RI.8.6	Determine an author's point of view or purpose in a text and analyze how the author acknowledges and responds to conflicting evidence or viewpoints.
	CCSS.ELA-LITERACY.SL.8.2	Analyze the purpose of information presented in diverse media and formats (e.g., visually, quantitatively, orally) and evaluate the motives (e.g., social, commercial, political) behind its presentation.
	MSU.8.OC.3	While participating in grade-appropriate oral communication, the student demonstrates the ability to listen critically and respond appropriately by using the speaker's nonverbal messages to infer speaker's point of view toward the content *(e.g., analyzing gestures, facial expressions, posture, and other body language to determine a speaker's point of view toward the content in an oral presentation).*
• Describe the purpose of a text	CCSS.ELA-LITERACY.RI.8.6	Determine an author's point of view or purpose in a text and analyze how the author acknowledges and responds to conflicting evidence or viewpoints.
	CCSS.ELA-LITERACY.SL.8.2	Analyze the purpose of information presented in diverse media and formats (e.g., visually, quantitatively, orally) and evaluate the motives (e.g., social, commercial, political) behind its presentation.

Analyzing Point of View and Purpose (continued)		
• Describe how differences in the point of view of the reader and the characters in a text can create dramatic irony	CCSS.ELA-LITERACY.RL.8.6	Analyze how differences in the points of view of the characters and the audience or reader (e.g., created through the use of dramatic irony) create such effects as suspense or humor.
Generating Claims, Evidence, and Reasoning		
• Generate claims and distinguish them from counterclaims	CCSS.ELA-LITERACY.SL.8.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
	CCSS.ELA-LITERACY.W.8.1.A	Introduce claim(s), acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
	MSU.8.F.1	While engaged in grade-appropriate writing tasks, the student demonstrates competence in a variety of formats by writing complex persuasive compositions *(e.g., writing persuasive compositions that employ clear claims, backing, warrants, and qualifiers).*
• Support claims with relevant and sufficient evidence as well as logical reasoning	CCSS.ELA-LITERACY.RI.8.1	Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.
	CCSS.ELA-LITERACY.RL.8.1	Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.
	CCSS.ELA-LITERACY.W.8.1	Write arguments to support claims with clear reasons and relevant evidence.
	CCSS.ELA-LITERACY.W.8.1.B	Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
	CCSS.ELA-LITERACY.W.8.9	Draw evidence from literary or informational texts to support analysis, reflection, and research.
Using Appropriate Citations		
• Use a standard citation format	CCSS.ELA-LITERACY.W.8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
• Avoid plagiarism	CCSS.ELA-LITERACY.W.8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

The purpose of the alignment shown in table 8 was twofold. First, we wanted to ensure that no essential content was overlooked or inadvertently deleted during the first five phases of our analysis. Second, identifying the standards associated with each element prepared us for the next phase by supplying specific examples and links to resources associated with each element.

Phase 7

During phase 7, initial instructional resources for each element were identified and, using the information in those resources, simpler and more complex content was articulated for each element. The target content (elements), simpler content, and more complex content were then organized into a proficiency scale (Marzano, 2010). The generic form of a proficiency scale is shown in table 9.

Table 9. Generic Form of a Proficiency Scale

4.0	**More complex content**
3.5	In addition to score 3.0 performance, partial success at score 4.0 content
3.0	**Target content**
2.5	No major errors or omissions regarding score 2.0 content, and partial success at score 3.0 content
2.0	**Simpler content**
1.5	Partial success at score 2.0 content, and major errors or omissions regarding score 3.0 content
1.0	With help, partial success at score 2.0 content and score 3.0 content
0.5	With help, partial success at score 2.0 content but not at score 3.0 content
0.0	Even with help, no success

Table 10 (p. 26) shows the proficiency scale for the ELA measurement topic of Analyzing Ideas and Themes at grades 9–10.

Table 10. Proficiency Scale for Analyzing Ideas and Themes at Grades 9–10

4.0	The student will: • Decide which of several possible themes in a text is the strongest (for example, make and defend the claim that Fitzgerald presents several themes in *The Great Gatsby,* including greed, power, betrayal, social stratification, and the American dream, but that social stratification is the strongest theme in the text).
3.5	In addition to score 3.0 performance, partial success at score 4.0 content
3.0	The student will: **AIT1—Determine the main ideas or themes in a text** (for example, explain that gender is a theme of Shakespeare's *The Tragedy of Macbeth* or that American ideals are a main idea of Lincoln's "Gettysburg Address"). **AIT2—Describe the development of an idea or theme over the course of a text** (for example, explain how the idea of reputation is developed throughout Miller's *The Crucible*).
2.5	No major errors or omissions regarding score 2.0 content, and partial success at score 3.0 content
2.0	**AIT1—**The student will recognize or recall specific vocabulary (for example, *connection, detail, main idea, paragraph, section, text, theme, topic*) and perform basic processes such as: • Identify important details and claims in a text. • Identify repeated details in a text. • Take notes about details and claims in a text. • Identify connections between important details or claims in a text. • Describe how repeated details change over the course of a text. • List common themes found in literature (person vs. nature, person vs. self, loyalty, family, ambition, independence, struggle against society). • Identify passages in a text related to a specific main idea or theme. **AIT2—**The student will recognize or recall specific vocabulary (for example, *chapter, character, detail, event, paragraph, section*) and perform basic processes such as: • Identify specific words that are related to a main idea or theme. • Explain how specific words strengthen a main idea or theme. • Identify specific sections of a text related to a main idea or theme. • Explain how specific sections of a text strengthen a main idea or theme. • Identify specific details that are related to a main idea or theme. • Identify the attitudes of particular characters toward a main idea or theme.
1.5	Partial success at score 2.0 content, and major errors or omissions regarding score 3.0 content
1.0	With help, partial success at score 2.0 content and score 3.0 content
0.5	With help, partial success at score 2.0 content but not at score 3.0 content
0.0	Even with help, no success

In this scale, the more complex 4.0 level content illustrates how the elements in the 3.0 section are related. The elements at the 3.0 level covary; that is, as performance on one goes up, performance on the other is also likely to go up. Additionally, all elements are unidimensional, as each articulates only one aspect of knowledge or a skill.

Using the Critical Concepts In Your School or District

Schools and districts interested in using the Critical Concepts have several options. First, a school or district might use the Critical Concepts measurement topics from appendices A, B, and C as a starting point for creating proficiency scales. Educators could use the lists as a foundation and proceed by adding or deleting topics according to their unique needs and situations. Once educators have a set of measurement topics they feel accurately represent the knowledge and skills their students should learn, they can compose proficiency scales for those topics.

Second, a school or district might begin by identifying those standards that they think are most important and then compare their list of essential content with the topics listed in appendices A, B, and C. Such a comparison provides an opportunity for educators to examine their decisions in the context of Marzano Research's analysis. As in the first option, educators can proceed to compose proficiency scales for their final list of topics.

Third, a school or district might decide to accelerate their journey toward a guaranteed and viable curriculum by purchasing the Critical Concepts proficiency scales created by Marzano Research (available in the summer of 2016) and customizing the proficiency scales for their unique needs and situations. This option allows educators to engage in revision, rather than creation, of proficiency scales; such work can be more efficient and less cognitively difficult than generating original proficiency scales. If a school or district decides to purchase the Critical Concepts proficiency scales, they should plan for educators to spend time customizing the measurement topics, elements, and proficiency scales for their specific context.

Aligning the Critical Concepts Measurement Topics and Elements

The process of aligning the Critical Concepts to school or district standards begins by comparing the Critical Concepts measurement topics and 3.0 elements to the essential knowledge and skills articulated in standards documents. This can be done by prioritizing school or district standards, sorting the prioritized standards into the Critical Concepts measurement topics, and comparing the prioritized standards within each measurement topic to the 3.0 elements within the measurement topic. Any gaps or overlaps should be noted; if knowledge or skills deemed essential for the school or district are not included in the Critical Concepts, they can be added as either 3.0 elements within an existing measurement topic or as additional measurement topics.

To add knowledge or skills to the Critical Concepts proficiency scales, educators should first determine if any Critical Concepts measurement topics are closely related to the knowledge or skills being added. For example, if a school or district deemed that knowledge and skills related to collaboration were essential but were not included in the Critical Concepts, they should first check to see if any Critical Concepts measurement topics are closely related to collaboration. Once they had verified that no measurement topics were related to collaboration, they might decide to add a new measurement topic. Beginning at the 3.0 level, they would construct a proficiency scale for the new content by articulating the target content, simpler content, and more complex content related to the element(s) within it.

Alternatively, if a school or district deemed that knowledge and skills related to the scientific process were essential but were not included in the Critical Concepts, they might discover that the elements to be added were closely related to elements already present in the measurement topic of Engineering Design. In such a case, they might decide to add knowledge or skills related to the scientific process as a 3.0 element within the existing measurement topic of Engineering Design, perhaps changing the measurement topic title to Scientific and Engineering Processes.

A crucial aspect of the decision to add new content within the 3.0 level of a proficiency scale is determining if the knowledge or skills to be added covary with the existing 3.0 elements in the measurement topic. *Covariance* means that two elements of knowledge or skill are so closely related that if student performance on one increases, it is likely to also increase for the other. When measuring student learning using a proficiency scale, educators typically assign one score to each student for each proficiency scale (that is, each measurement topic), rather than assigning separate scores for each element within a proficiency scale. Because a student will be assigned a score that measures their performance with all elements at the 3.0 level of the scale, all 3.0 elements within a measurement topic should covary. Therefore, any elements being added to a measurement topic at the 3.0 level must covary with elements already there. Additionally, we recommend that measurement topics have one to three (and no more than four) elements at the 3.0 level. Therefore, if a measurement topic already has three or four elements at the 3.0 level, it may be advisable to create a new measurement topic for additional knowledge or skills.

Revising the Critical Concepts Proficiency Scales

In the Critical Concepts proficiency scales, the simpler content articulated at the score 2.0 level is a list of possible vocabulary terms and basic processes that students could be expected to master as they work toward the 3.0 level elements. This does not imply that students must master everything listed at the score 2.0 level. Rather, educators should customize the proficiency scale for their specific school or district by adding or deleting vocabulary terms and basic processes at the 2.0 level. As a general rule, educators should select vocabulary terms and 2.0 elements that they intend to directly teach and assess.

For example, consider the proficiency scale in table 10 (p. 26). An educator might customize the proficiency scale by narrowing the vocabulary list for the first element (AIT1) to three important terms: *main idea*, *theme*, and *detail*. Additionally, he or she might combine the first two elements at the 2.0 level into a single element and delete the third, fourth, and seventh elements to create the revised vocabulary list and 2.0 elements for AIT1 shown in table 11.

Table 11. Revised 2.0 Section of the Critical Concepts Proficiency Scale for Analyzing Ideas and Themes at Grades 9–10

2.0	**AIT1—**The student will recognize or recall specific vocabulary (for example, *detail, main idea, theme*) and perform basic processes such as: • Identify important details and claims in a text, including repeated details. • Describe how repeated details change over the course of a text. • List common themes found in literature (person vs. nature, person vs. self, loyalty, family, ambition, independence, struggle against society).

This revision process could be repeated for AIT2 and for the elements of other proficiency scales to create a focused set of proficiency scales that is customized to the unique needs and situation of an individual school or district. We recommend, however, that educators engage in this type of revision work as teams within a school or district; the final version of a proficiency scale for a school or district should be agreed to by all educators teaching the content contained within it, and all educators teaching that content at a specific grade level should use the same version of the proficiency scale.

Creating Separate Proficiency Scales

As exemplified in table 10 (p. 26), when a measurement topic has more than one 3.0 element, we specify in the Critical Concepts proficiency scales which elements of the simpler 2.0 content correspond to which element in the 3.0 section. This allows educators, if they wish, to create separate proficiency scales for each element in the 3.0 section by simply moving the 3.0 elements and their corresponding 2.0 content into separate proficiency scale documents and composing a statement of more complex 4.0 content for each element.

Regarding the decision to create separate proficiency scales for each 3.0 element from a Critical Concepts proficiency scale, we offer one cautionary note: Educators should keep in mind that when they move the 3.0 elements (and corresponding 2.0 elements) from a proficiency scale into separate proficiency scales, they are increasing the number of topics on which they will assign scores to students. For example, if an educator used the scale in table 10 as it is presented, he or she would assign scores for the one topic of Analyzing Ideas and Themes. If an educator decided to split the proficiency scale in table 10 into two separate scales, he or she would assess and score students on each element separately. Thus, each student would have a set of scores for the element "Determine the main ideas and themes in a text" and another set of scores for the element "Describe the development of an idea or theme over the course of a text." It follows that a report card or tracking chart for a student would also list each element individually. In sum, as more proficiency scales are split, educators must keep track of more scores for each student.

Summary

This report summarizes the process used to select the Critical Concepts elements, organize them into measurement topics, and compose a proficiency scale for each measurement topic. Additionally, this report explains how a school or district might use the Critical Concepts measurement topics and proficiency scales to facilitate and accelerate their work toward a guaranteed and viable curriculum. While each school or district should customize the work described here for its unique situation and needs, our hope is that this project provides a useful foundation for such an endeavor.

Notes

1. The lists of measurement topics in appendices A, B, and C are preliminary. As a proficiency scale is composed for each, measurement topics will be refined further, and we may discover that a measurement topic needs to be split (because it contains elements that do not covary) or that two measurement topics need to be combined (because they contain elements that covary with each other). Also, phases 6 and 7 may involve further refinement of the language used to articulate each measurement topic and the order in which the measurement topics are presented.
2. As of January 2016, we have completed proficiency scales for the following areas: grade 8 ELA, grade 8 math, grades 9–10 ELA, grades 11–12 ELA, high school math, and high school science. Therefore, the lists of measurement topics in appendices A, B, and C for those areas have been refined and can be considered final (although slight changes may occur as we finalize the complete K–12 sets of proficiency scales).
3. Finally, we have articulated two sets of measurement topics for ELA at the high school level: grades 9–10 ELA and grades 11–12 ELA. As implied by this organization, students work on the same set of measurement topics and elements in grade 9 and grade 10 and the same set of measurement topics in grade 11 and grade 12, applying the knowledge and skills articulated in each proficiency scale to a wide range of texts. Before using the Critical Concepts proficiency scales, a school or district should articulate the specific texts to which students will apply the knowledge and skills articulated in each measurement topic at each grade level. For example, at grade 9, students might determine the main ideas or themes in texts such as Homer's *The Odyssey*, Steinbeck's *The Grapes of Wrath*, Lee's *To Kill A Mockingbird*, and Williams' *The Glass Menagerie*. At grade 10, students might determine the main ideas or themes in texts such as Ovid's *Metamorphoses*, Voltaire's *Candide*, Kafka's *The Metamorphosis*, and Shakespeare's *The Tragedy of Macbeth*.

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APPENDIX A:
ENGLISH LANGUAGE ARTS MEASUREMENT TOPICS

Grades 11–12

Analyzing Text Organization and Structure
Analyzing Ideas and Themes
Analyzing Claims, Evidence, and Reasoning
Analyzing Narratives
Analyzing Point of View and Purpose
Comparing Texts
Analyzing Style
Analyzing Language
Generating Text Organization and Structure
Generating Claims, Evidence, and Reasoning
Research Process
Generating Conclusions
Generating Narratives
Revision and Style
Editing

Grades 9–10

Analyzing Text Organization and Structure
Analyzing Ideas and Themes
Analyzing Claims, Evidence, and Reasoning
Analyzing Narratives
Analyzing Point of View and Purpose
Comparing Texts
Analyzing Language
Generating Text Organization and Structure
Generating Claims, Evidence, and Reasoning
Research Process
Generating Narratives
Generating Point of View and Purpose
Revision and Style
Editing

Grade 8

Analyzing Text Organization and Structure
Analyzing Ideas and Themes
Analyzing Claims, Evidence, and Reasoning
Analyzing Narratives
Analyzing Point of View and Purpose
Comparing Texts
Analyzing Language
Generating Text Organization and Structure
Generating Claims, Evidence, and Reasoning
Generating Narratives
Considering Point of View, Purpose, and Audience
Revision and Style
Appropriate Verb Usage
Using Appropriate Citations
Editing

Grade 7

Analyzing Text Organization and Structure
Analyzing Ideas and Themes
Analyzing Claims, Evidence, and Reasoning
Analyzing Narratives
Analyzing Point of View and Purpose
Comparing Texts
Analyzing Language
Generating Text Organization and Structure
Using a Specific Structure
Outlining
Generating Transitions
Generating Claims, Evidence, and Reasoning
Using Appropriate Citations and Sources
Generating Narratives
Generating Point of View and Purpose
Writing for a Specific Audience
Choosing Words
Punctuation, Capitalization, Spelling, and Grammar
Revision and Editing

Grade 6

Analyzing Text Organization and Structure
Analyzing Ideas and Themes
Analyzing Claims, Evidence, and Reasoning
Analyzing Narratives
Analyzing Characters
Analyzing Point of View and Purpose
Comparing Texts
Analyzing Language
Analyzing Words
Generating Text Organization and Structure
Generating Claims, Evidence, and Reasoning
Using Appropriate Citations and Sources
Generating Narratives
Generating Point of View and Purpose
Writing for a Specific Audience
Using Words
Punctuation, Capitalization, and Spelling
Revision and Editing

Grade 5

Decoding
Analyzing Text Organization and Structure
Analyzing Ideas and Themes
Analyzing Claims
Analyzing Narratives
Comparing Texts
Analyzing Words
Generating Text Organization and Structure
Generating Sentence Structure
Generating Claims
Using Citations
Generating Narratives
Generating Point of View and Purpose
Writing for a Specific Audience
Using Specific Words and Parts of Speech
Punctuation, Capitalization, and Spelling
Revision and Editing

Grade 4

Decoding
Analyzing Text Organization and Structure
Analyzing Ideas and Themes
Analyzing Claims
Analyzing Narratives
Analyzing Point of View and Purpose
Comparing Texts
Analyzing Words
Generating Text Organization and Structure
Generating Sentence Structure
Generating Claims
Using Sources
Generating Narratives
Generating Point of View and Purpose
Writing for a Specific Audience
Using Words
Punctuation, Capitalization, and Spelling
Revision and Editing

Grade 3

Decoding
Analyzing Text Organization and Structure
Analyzing Ideas and Themes
Analyzing Narratives
Analyzing Point of View and Purpose
Comparing Texts
Analyzing Words
Generating Text Organization and Structure
Generating Sentence Structure
Generating Claims
Using Sources
Generating Narratives
Generating Point of View and Purpose
Writing for a Specific Audience
Using Words
Punctuation, Capitalization, and Spelling
Revision and Editing

Grade 2

Phonics
Decoding
Analyzing Text Organization
Analyzing Ideas and Themes
Analyzing Claims
Analyzing Narratives
Analyzing Point of View and Purpose
Comparing Texts
Analyzing Words
Generating Text Organization
Sentence Structure
Generating Claims
Generating Narratives
Using Words
Punctuation, Capitalization, and Spelling
Revision and Editing

Grade 1

Phonics
Decoding
Distinguishing Between Types of Texts
Analyzing Text Organization
Identifying Main Idea
Analyzing Narratives
Analyzing Point of View
Comparing Texts
Analyzing Words
Printing
Generating Text Organization
Sentence Structure
Summarizing and Retelling
Generating Claims
Generating Narratives
Using Words
Punctuation, Capitalization, and Spelling
Revision and Editing

Kindergarten

Phonics
Print Concepts
Analyzing Text Organization
Main Idea
Analyzing Narratives
Comparing Texts
Analyzing Words
Printing
Generating Text Organization
Sentence Structure
Summarizing
Generating Claims
Generating Narratives
Using Words
Punctuation, Capitalization, and Spelling

APPENDIX B:
MATHEMATICS MEASUREMENT TOPICS

High School

Components of an Expression
Context of an Expression
Rational Numbers and Expressions
Rational Exponents and Radicals
Adding and Subtracting Polynomial Expressions
Multiplying and Dividing Polynomial Expressions
Evaluating Polynomials
Factoring Expressions
Equations and Inequalities
Generating Equations and Inequalities
Linear Equations and Inequalities
Systems of Equations and Inequalities
Functional Relationships and Function Notation
Domain and Range of Functions
Quadratic Equations and Functions
Graphing Functions
Generating Functions
Comparing Functions
Inverse Functions
Polynomial, Radical, and Rational Functions
Combining Functions
Arithmetic and Geometric Sequences
Finite Geometric Sequences
Exponential and Logarithmic Functions
Parallel and Perpendicular Lines
Partitions of Line Segments
Angles and Transversals of Parallel Lines
Basic Line Constructions
Angle Constructions
Non-Rigid Transformations
Transformations, Similarity, and Congruence
Similarity in Triangles
Triangle Properties
Circumscribed and Inscribed Circles of Triangles
Components of a Circle
Proportions of a Circle
Angles of a Circle
Equation of a Circle
Conic Sections
Circle Polygon Constructions
Circle Area Measurements
Properties of Parallelograms
Polygons on the Coordinate Plane
Volume of Three-Dimensional Figures
Modeling
Trigonometric Ratios
Trigonometric Ratios in Non-Right Triangles
Trigonometric Identities and Formulas
Trigonometric Functions on the Unit Circle
Modeling with Trigonometric Functions
Matrix Operations
Vector Operations
Linear Transformations
Matrix Determinants and Inverses
Complex Numbers
Complex Numbers on the Plane
Visual Data Representation and Interpretation
Algebraic Data Representation and Interpretation
Data Comparisons
Probability
Probability and Combinatorics
Discrete Probability Distributions
Probability Density Functions
Statistical Investigation

Grade 8

Proportional Relationships
Slope and Intercept
Algebraic Expressions
Systems of Linear Equations
Quadratic Equations
Concept of Functions
Cubes and Squares
Exponents
Scientific Notation
Rational and Irrational Numbers
Lines
Angles
Similarity, Congruence, and Transformation
Pythagorean Theorem
Properties of Shapes
Area and Perimeter
Volume
Measurement
Bivariate Data
Scatterplots and Data Association
Distributions
Probability

Grade 7

Constructing Triangles
Rates and Ratios
Proportional Relationships
Rate of Change
Converting Fractions, Decimals, and Percent
Manipulating Geometric Figures
Measuring Angles
Inequalities
Squares and Exponents
Signed Numbers
Linear Equations
Rational and Irrational Numbers
Central Tendencies in Distributions
Order of Operations
Area and Volume
Variability in Distributions
Measurement Units
Compound Events
Perimeter and Circumference
Models of Probability
Probability and Frequency
Absolute Value
Problems with the $p(x + q) = r$ Formula
Random and Representative Samples
Classifying Lines, Angles, Rays, and Line Segments

Grade 6

Inequalities
Equivalent Expressions
Equations with Specific Forms
Conversion
Evaluating Expressions
Writing Expressions
Division
Independent and Dependent Variables
Number Lines
Coordinate Planes
Distance in a Coordinate Plane
Concept of Ratios
Equivalent-Ratio Tables
Ratio Conversion
Unit Rate Problems
Probability
Positive and Negative Numbers
Displaying Data
Measurement Units
Representing Data
Distribution Shapes
Central Tendencies in Distributions
Variation in Distributions
Decimals
Factors and Multiples
Fractions
Area
Volume
Perimeter
Two-Dimensional Shapes
Three-Dimensional Shapes
Pi
Functions
Symmetry and Congruence
Sample Spaces

Grade 5

Decimals
Fractions
Area
Volume
Multiplication
Division
Comparison Symbols (including =, ≠, <, and >)
Exponents
Ordered Pairs and Coordinate Systems
Addition and Subtraction
Perimeter
Data Representation
Central Tendency in Data Sets
Numerical Patterns
Using of Braces, Brackets, and Parentheses
Probability
Symmetry
Two-Dimensional Figures
Basic Functions
Factors and Multiples
Measurement

Grade 4

Fractions
Equivalent Fractions
Properties of Multiplication
Word Problems Involving Addition
Word Problems Involving Subtraction
Word Problems Involving Multiplication
Word Problem Involving Division
Factors and Multiples
Conversions
Comparing Numbers, Decimals, and Fractions
Comparing Angles
Finding and Measuring Angles
Properties of Angles
Area and Perimeter
Lines, Line Segments, Rays, and Points
Order of Operations
Multi-Digit Numbers
Variables
Equivalent Measures
Measuring Temperature
Measuring Time
Measuring Length
Symmetry
Flips
Slides
Turns
Parallelograms, Rhombuses, Trapezoids, and Right Triangles
Cubes and Prisms
Data Representation
Probability
Patterns
Volume
Ordered Pairs

Grade 3

Estimation
Comparisons
Solving for Unknown Variables
Measuring Time
Measuring Length
Measuring Weight
Measuring Mass
Measuring Volume and Capacity
Patterns
Properties of Operations
Properties of Fractions
Expressing Fractions
The Concept of Area
Computing Area
Multiplication
Division
Addition
Subtraction
Shapes
Perimeter
Data Representation
Data Analysis
Numerical Versus Categorical Data
Place Value
Transformations
Symmetry
Ordering Numbers
Lines
Probability
Graphing

Grade 2

Concept of Addition
Process of Addition
Concept of Subtraction
Process of Subtraction
Odd and Even
Numbers to 1000
Skip Counting
Number Line Diagrams
Inequalities and Comparisons
Place Value
Measuring Length
Measuring Capacity
Measuring Time
Money
Data Representation
Data Analysis
Two-Dimensional Shapes
Three-Dimensional Shapes
Division
Multiplication
Fractions
Patterns
Transformations, Congruency, and Symmetry

Grade 1

Counting and Representing Numbers
Ordinal Numbers
Addition, Subtraction, and Counting
Place Value
Addition Within 100
The Concept of Addition
Addition of Three Numbers
Addition and Regrouping
The Concept of Subtraction
Subtraction of Three Numbers
Subtraction and Regrouping
Common Subtraction Problems
Decomposing Numbers
Greater Than and Less Than
Evaluating Equations
Patterns
Drawing Shapes
Understanding Two- Versus Three-Dimensional Shapes
Composite Shapes
Symmetry
Shape Transformation
Multiplication
Division
Division Into Equal Shares
Nonstandard Measurement
Standard Measurement
Data Representation
Data Analysis
Money
Classification

Kindergarten

Number Concepts
Position and Ordering
Equality
Patterns and Comparisons
Addition
Subtraction
Representing Problems
Time and Temperature
The Concept of Measurement
Shapes

APPENDIX C: SCIENCE MEASUREMENT TOPICS

High School

Energy Conversion
Energy Flow in a System
Entropy
Force
Gravity
Electromagnetism
Forces Within a Field
Electromagnetic Radiation
Information Technologies
Atomic Structure
Chemical Reactions
Chemical Reaction Factors
Fission, Fusion, and Radioactive Decay
Molecular-Level Structures
Engineering Design
Big Bang Theory
Stars
Earth's History
Geologic Processes
Earth Systems
Climate Change
Natural Hazards
Natural Resources
Carbon-Based Molecules
Multicellular Organisms
Cellular Respiration and Photosynthesis
Homeostasis
Protein Synthesis
Inheritable Genetic Traits
Trait Variation in a Population
Survival and Adaptation
Biological Evolution
Ecosystem Populations
Matter and Energy in Ecosystems
Biodiversity

Middle School

Air and Water Circulation
Atmospheric Factors and Processes
The Water Cycle
Gravity Inside and Outside the Solar System
The Solar System
Relationships Between the Sun, Moon, and Earth
Environmental Impacts
Fossils
Earth Processes
Plate Movement
Natural Disasters
Cells (General)
Prokaryotic Versus Eukaryotic Cells
Ecosystems
Food Chains and Food Webs
Reproduction
Genetics
Evolution
Specialized Systems
Organization Within Systems
The Neurosystem
Embryology
Photosynthesis
Classification of Organisms
Elements and Compounds
Chemical Reactions
Electricity
Magnetism
Gravitational Forces
Newton's Laws
Vectors
Kinetic and Potential Energy
Sources and Characteristics of Energy
Thermal Energy
Waves
Design
Testing Ideas

Grade 5

Properties of Matter
Ecosystems
Energy
Electricity
Gravity
Force and Motion
Magnetism
Earth's Features
Earth Systems
Characteristics of Organisms
Photosynthesis
The Sun
Universe
Problem Solving
Experimentation
Engineering
Fossils
Evolution

Grade 4

Speed, Energy, and Collisions
Energy Conversion
Magnetic Forces
Sound
Light
Heat
Electricity and Circuits
Waves
Plant Structures
Animal Structures and Characteristics
Life Cycles
Plant and Animal Needs
Fossils and Rock Formations
Geographic Features
Soil and Minerals
Weathering and Erosion
Fuel and Energy
Interactions Between the Environment and Organisms
Identifying Problems and Solutions
Conducting Experiments
Properties of Water
State Changes
Weight
Astronomy
Learned and Inherited Traits
Classifying Organisms

Grade 3

Force and Motion
Electricity
Magnetism
Life Cycles
Ecosystems
Light
Traits
Fossils
Weather
Scientific Practice
Problem Solving
Experimentation
Engineering
Earth Materials
Solar System
Food Chains and Webs
Classification
Properties
Sound

Grade 2

Changes to Earth's Surface
Landforms
Water
Problem Solving
Engineering
Animal Behavior
Ecosystems
Classification
Properties
Heating
Cooling
Weather
Rocks
The Sun
Extinction
Plants
Genetic Traits
Force and Motion
Electricity
Sound and Vibration

Grade 1

Sun and Stars
The Moon
Seasons
Animal Parents and Offspring
Animals
Ecosystems
Plants
Sound and Vibration
Light
Problem Solving
Water
Properties and Classification
Earth
Force and Motion
Scientific Process
Electricity

Kindergarten

Force and Motion
The Sun
Organisms
Ecosystems
Weather
Problem Solving
Engineering
Water
Light
Gravity